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Subject: Radiometric Averaging versus Thermal Averaging of the OBC Blackbody

Summary

When obtaining the spectral radiance of the OBC blackbody, with its twelve thermistors, it is possible to either average the twelve thermistor measurements and apply the Planck function to the resultant value (thermal averaging) or to apply the Planck function to each of the twelve thermistors and average the resultant value (radiometric averaging). I have developed a model through which to study this phenomena and conclude that for the expected thermal gradients of the OBC blackbody, the difference is trivial. The current expected thermal gradient of the OBC blackbody is .052K. This study concludes that at normal on-orbit operating temperatures, a gradient of at least 2.2K must be achieved before a .1% radiometric error variation is observed between these techniques in the SWIR bands. This permissible gradient becomes as high as 13K in the extreme LWIR bands. Similar results are observed when using the OBC blackbody in its heated mode. Therefore, with the current Level 1B software designed to perform thermal averaging, is see no reason to change this, especially if the change involves more computer resources.

Methodology

To model this phenomena, two source temperatures were used: nominal and nominal + gradient. The Planck function was applied to each and the resultant was averaged (radiometric averaging). The Planck function was also applied to the average of the two temperature values (thermal averaging). The residual error was then obtained between the two averaging techniques by differencing the results of each technique and dividing by the thermal averaging technique's results.

gradient 0.052
T1 295
T2 295.052
Tavg 295.026

assume emissivity = 1
 $Lbb(Lavg) = (Lbb1 + Lbb2) / 2$
Residual = $100 * (Lbb(Tavg) - Lbb(Lavg)) / Lbb(Tavg)$

Band	Wavelength	Lbb1	Lbb2
20	3.75	0.360828306	0.361656339
21	3.959	0.546659355	0.547847537
22	3.959	0.546659355	0.547847537
23	4.05	0.643553575	0.644920897
24	4.465	1.210204831	1.212536869
25	4.515	1.29185163	1.294313406
27	6.715	6.113474906	6.1213056
28	7.325	7.247119967	7.255629248
29	8.55	8.683200191	8.691934171
30	9.73	9.086353922	9.094384537
31	11.03	8.762973638	8.769805284
32	12.02	8.206791121	8.212662017
33	13.335	7.286280508	7.290978724
34	13.635	7.065519802	7.0699754
35	13.935	6.844299606	6.848522753
36	14.235	6.623856483	6.627857448

Lbb(Tavg)	Lbb(Lavg)	Residual
0.361242122	0.361242322	-5.55759E-05
0.547253176	0.547253446	-4.93579E-05
0.547253176	0.547253446	-4.93579E-05
0.644236933	0.644237236	-4.69547E-05
1.211370392	1.21137085	-3.78434E-05
1.293082041	1.293082518	-3.6917E-05
6.117389345	6.117390253	-1.48418E-05
7.251373734	7.251374608	-1.20422E-05
8.687566468	8.687567181	-8.20399E-06
9.090368697	9.09036923	-5.8627E-06
8.766389097	8.766389461	-4.15746E-06
8.209726303	8.209726569	-3.24129E-06
7.288629445	7.288629616	-2.35345E-06
7.067747446	7.067747601	-2.18991E-06
6.84641104	6.846411179	-2.03812E-06
6.62585684	6.625856965	-1.89704E-06